Augmented reality guided percutaneous cannulated screw placement for pelvic trauma

Eyal Yaacobi, MD[1], Wendell Gibby, MD[2,3]

[1] Meir Medical Center, Kfar Saba, Israel, Department of Orthopedics.
[2] Novarad Corporation, Provo, Utah, USA.
[3] Department of Radiology, University of California San Diego, San Diego, California, USA.

Accepted for presentation at the 1st Triennial Meeting IOTA / Trauma Dagen 2022

Objective:

Fixation of pelvic fractures with conventional techniques has known difficulties of complexity, time, accuracy, and extensive radiation exposure. For example, placement of a percutaneous sacroiliac fusion screw requires a long trajectory, with significant distance from the entrance of the skin to the bone, and the need to navigate across bony structures while avoiding adjacent critical anatomy. Similarly, the placement of anterior or posterior columns demands precise navigation along a narrow trajectory. Presented here is promising data from a cadaver trial for navigating percutaneous cannulated screws of anterior and posterior column fractures and sacroiliac fusion procedures of the pelvis.

Methods:

CT imaging was acquired with image visible alignment codes (AprilTags) adhered to the skin of cadavers (Figure 1). Preoperative planning of trajectory, length, distance, and diameter were obtained on the Novarad 3-D plus workstation (Novarad, Provo, UT). Data was wirelessly transferred to the VisAR augmented reality guidance system (Novarad, Provo, UT) from an encrypted optical code retrieval system (Cryptochart, Novarad, Provo, UT). Voice command workflow streamlined registration of the data from the CT scan to the patient. VisAR was aligned with a 2.8mm wire guide (DePuy Synthes, Oberdorf, Switzerland). The navigation guide was affixed with an optical tracker for precise wire guidance. Navigation consisted of following 3-dimensional holographic virtual guides (Figure 1) as well as tool tracking in multiplanar space from coronal, axial, and sagittal views. Four SI joint fusion, 3 anterior column (Figure 2), and 1 posterior column screws were placed. Fluoroscopy was not used for navigation.

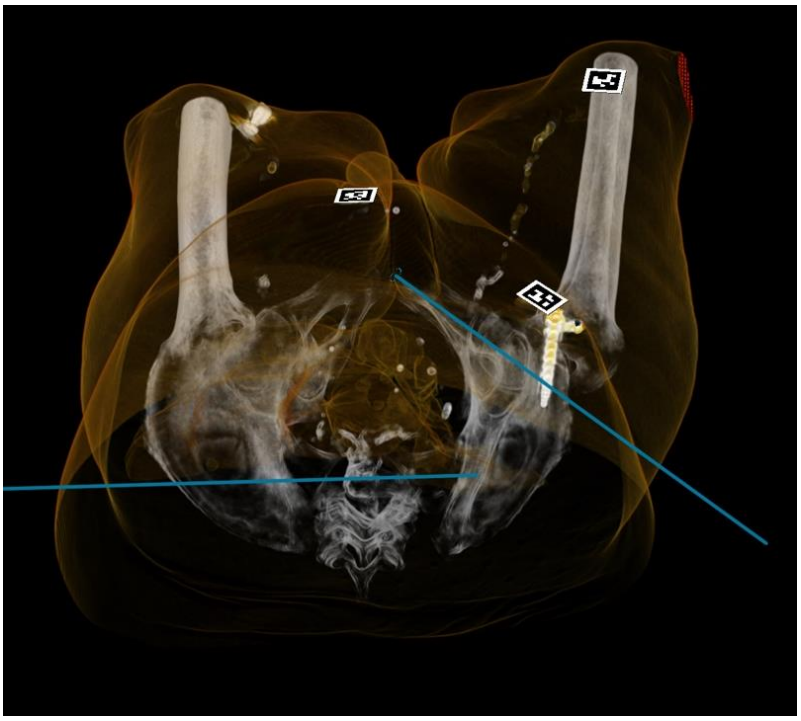

Figure 1. Annotated presurgical virtual pathways (blue lines) for S1 and anterior column screw navigation. Note optical AprilTags, one of which is mounted on a bone screw.

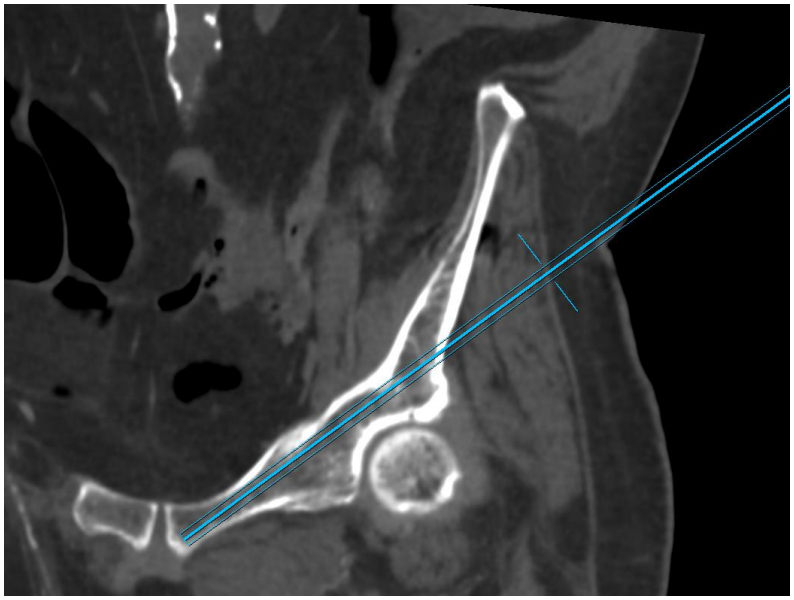

Figure 2. Holographic view through the headset of anterior column screw trajectory.

Results:

Screw locations	Correctly Placed
4 SI fusion joint	4/4
3 anterior column	2/3
1 posterior column	1/1

Summary:

Overall, the system proved that successful virtual navigation of long cannulated screws could be performed in a challenging anatomic environment with significant success. Modest improvements in the technique will allow the surgeon to perform fixation faster and with greater accuracy. Augmented reality has been successfully deployed for both spine and cranial applications.[1,2]

References

1 Felix, Brent MD; Kalatar, Seyed Babak MD; Moatz, Bradley MD; Hofstetter, Christoph MD, PhD; Karsy, Michael MD, PhD; Parr, Ryan PhD; Gibby, Wendell MD. Augmented Reality Spine Surgery Navigation: Increasing Pedicle Screw Insertion Accuracy for Both Open and Minimally Invasive Spine Surgeries. SPINE: June 15, 2022 - Volume 47 - Issue 12 - p 865-872 doi: 10.1097/BRS.0000000000004338

2 Gibby W, Cvetko S, Gibby A, Gibby C, Sorensen K, Andrews EG, Maroon J, Parr R. The application of augmented reality-based navigation for accurate target acquisition of deep brain sites: advances in neurosurgical guidance. J Neurosurg. 2021 Dec 17:1-7. doi: 10.3171/2021.9.JNS21510. Epub ahead of print. PMID: 34920422.